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Commentary

Bracket slot size selection: after all a matter of taste?

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Abstract

The publication of the 3-paper series on the effects of two slot sizes on treatment parameters on this issue, targets a topic, which has attracted a lot of discussion based primarily on anecdotal evidence. The conclusive evidence contributed on the lack of variation of treatment variables with slot size selection, clarifies one of the traditional beliefs on this issue; several others still hold strong however. This commentary has the objective of highlighting some points, which could be taken into consideration in interpreting the results of this 3-part trial.

[Text begins here]

The series of the 3 papers *A randomized clinical trial of the effectiveness of 0.018-inch and 0.022-inch slot orthodontic bracket systems: part 1—duration of treatment* by Yassir et al; *A randomized clinical trial of the effectiveness of 0.018-inch and 0.022-inch slot orthodontic bracket systems: part 2—quality of treatment* also by Yassir et al; and *A randomized clinical trial of the effectiveness of 0.018-inch and 0.022-inch slot orthodontic bracket systems: part 3—biological side-effects of treatment* by El-Angbawi et al, all originating from the group led by D. Bearn, contribute essential information for the informed choice of a slot size. This topic has rather been a matter of personal preference and training influences, than an evidence-derived decision. Although many attempts have been in the past to assign specific advantages or limitations to the 0.018-inch and 0.022-inch, the resultant statements were largely confined within the anecdotal evidence area–which is a kind of oxymoron since these do not qualify to be considered evidence, anyway. The truth is that there have been efforts to look at the issue in a more scientific manner by deducting elements of efficiency or other parameters such as magnitude of forces, through indirectly studying the forces and moments developing during engagement with various wise sizes and compositions of alloys; duration of treatment; and torque control. However conclusive hard data derived from RCTs are lacking and hence the publication of the series of these papers is of high importance.

There have been different perspectives in examining the issue of slot size picked [1]. What one could identify as versatility provided by the 0.022 slot owing to the ability of use of a larger selection of wires that could fit, another could consider as inefficiency because of the same reason. Moreover, there have been several misconceptions as to the effect of the size of wire on its torsional performance. Larger cross-section wires do not necessarily possess higher efficiency in torque since the torsional stiffness is more affected by the alloy composition than the escalation to a larger size. Table 1 derived from data from the study of Kusy, demonstrates that wires with a cross-section of 0.016X0.022-inch, yield a torsional stiffness with a relative ratio of 6, which means a variation of 600% among different alloys (when comparing for example NiTi to stainless steel) [2]. This implies that although a rectangular cross-section is inserted, the effectiveness of torque application may be poor when low modulus wires are selected. Therefore, the notion that because of the introduction of new wires with low modulus of elasticity, the slot-size could be reconsidered and 0.018-inch slot should be considered outdated [3] is fundamentally problematic, because larger slots would result in the necessity at some point of time to insert larger rectangular stainless steel wires, to provide torque, which would in turn apply higher forces in second order misalignments, and show bracket positioning mistakes.

The reader should appreciate that root resorption as studied in one of the paper series, might not be directly associated with the slot size, rather, showing more relevance to the configuration of the biomechanical scheme followed. In that sense, it could be that identical slots and wires used with different techniques with variation in intrusion, tipping, double trip, jiggling, or persistent tooth movement, on patients with different metabolic or root anatomy, might yield unpredictable resorption extent. At any rate, this hypothesis was legitimately handled in this RCT.

Some comments are nonetheless due on the accompanying studies: the first relates to the fact that the authors, in an attempt to standardize the stages of treatment and mechanotherapy, have selected 3 wires per group with identical initial wire. This has resulted in essentially negating the concept of smaller slot size, which was utilized to attain control of the spatial orientation of the tooth with less wire changes and smaller cross-section wires; or correspondingly, that of a larger slot, which is employed to initiate treatment with a larger cross-section wire. By doing so, the authors introduced a difference in the step-wise escalation of wire stiffness in bending (Table 2), which might be more essential parameter than just the number of wires used. A closer look at the increase of stiffness shows that there is a jump of 500% in bending stiffness between the first and second wires in the 0.018 slot whereas the corresponding figure in the 0.022 slot is 800% owing to the fact that, while the two groups started with the same wire, the 0.022 slot one received a larger cross-section as a second wire. Moreover, these figures for the 2nd and 3rd wire are 280% vs 500% for the 0.018 and 0.022 slots, respectively, which means that the standardization of the number of wires produced an imbalanced effect on the stiffness (and forces) applied. In torsional stiffness things look fairly balanced and despite the big jump, it seems that wire changes produced similar increase in stiffness. Therefore the generalizability of the results is a bit limited, however the slack or free play was effectively normalized since the two terminal wires used in the two slots possess identical lack (about 14 degrees). In fairness to the authors, any selection of wire sequence, would have generated a discussion about its appropriateness or acclamation, as there are no specific guidelines and the multiplicity of wires available (sizes and composition) allows for a wide selection.

Secondly, a parameter which has not been assessed is the case of retraction of anteriors in extraction cases. In this scenario, the 0.022 size shows some disadvantages in the conventional ligation mode, arising from the use of larger wires, and the resultant higher forces, which should be taken into consideration and managed by using complex configurations or exceedingly large loop heights. A 0.017X0.025-inch stainless steel archwire with a tear drop-shaped loop, when activated produces a force of 1020 g for a 6 mm-height loop, and 265 g when the height is increased to 10 mm. The corresponding values for the 0.019X0.025-inch wire, are 1420 and 470 g, respectively, which are exceedingly high [4]. Yoshida has proposed alternative designs such as the keyhole loop or modifying existing shapes by reducing for example the thickness of the wire in the dome of the loop through wire grinding, thereby reducing the magnitude of force by 50% and increasing the moment-to-force ratio by 80% (from 5.5 to 9.3). The use of sliding mechanics to bypass the problem of high forces, generates a difficulty in controlling torque, and is also not favouring the 0.022 option: in a 0.018-inch slot, a 0.017X0.022-inch archwire requires a power arm of 9 mm to achieve bodily movement, whereas the corresponding figure for the 0.022 slot with a 0.019X0.025-in archwire, is

11.5 mm [5]. This makes it uncomfortable for the patient as it perhaps impinges in the vestibular area, which shows a decreased height as the tooth is being distalized.

The authors of the laborious series of papers have undertaken the task of monitoring a relatively large number of patients throughout the entire treatment time and focused on an issue, for which a lot of discussion based on empirical evidence and opinions has been generated, with a notable absence of hard facts. Within the limitations of the given design, which inevitably surface anytime an investigation pertinent to treatment variables is undertaken in a specialty, which primarily does not manage an objectively-defined pathological entity, they have contributed a lot by setting their objectives simple and clear. Their dedication to the process of systematically examining fundamental, albeit properly unexplored treatment parameters, should be acknowledged.

Table 1

Torsional stiffness indices of rectangular wires of various cross-sections and alloy compositions. Note that within the same size, there is a variation as big as 600% and thus a notable difference in efficiency is expected.

	TORSIONAL STIFFNESS INDEX		
Wire cross section (in)	**NiTi**	**TMA**	**Stainless steel**
0.016X0.022	1.5	2.5	8.8
0.017X0.025	1.9	3.8	12
0.019X0.025	3	5.2	18.1

Stiffness index is a number without units and provides an estimate of the relative stiffness of two wires (for example an index of 2 implies that this wire has double the stiffness of another which has 1). Values derived from the nomograms proposed by Kusy [2].

Table 2

Difference in bending stiffness index of wires utilized in the study. By escalating in size between 1st and 2nd wire for the 0.018 and 0.022 slots, a 500% vs 800% difference in increase in bending stiffness is noted, respectively; corresponding difference between the 2nd and 3rd wire for the two slots is 280% (0.018) and 500% (0.022).

Differences in torsional stiffness index by escalating between 2nd and 3rd wire between the 0.018 and 0.022 slots are similar, i.e., 530% vs. 500%, respectively.

WIRE USED	BENDING STIFFNESS INDEX 0.018 GROUP	BENDING STIFFNESS INDEX 0.022 GROUP	TORSIONAL STIFFNESS INDEX 0.018 GROUP	TORIONAL STIFFNESS INDEX 0.022 GROUP
1ST WIRE	0.5	0.5	-	-
2ND WIRE	2.5	4	1.5	2.5
3RD WIRE	7	20	7	18

Stiffness index is a number without units and provides an estimate of the relative stiffness of two wires (for example an index of 2 implies that this wire has double the stiffness of another which has 1). Values derived from the nomograms proposed by Kusy [2]

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